PHYTOPATHOLOGISCH LABORATORIUM "WILLIE COMMELIN SCHOLTEN"

18 december 1894 — 18 december 1969

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MEDEDELING 75
PHYTOPATHOLOGISCH LABORATORIUM
"WILLIE COMMELIN SCHOLTEN"
BAARN, NETHERLANDS

COMMONWEALTH MYCOLOGICAL INST.
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PHYTOPHATOLOGISCH LABORATORIUM „WILLIE COMMELIN SCHOLTEN" 18 DECEMBER 1894 - 18 DECEMBER 1969

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door

L. C. P. KERLING

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BAARN - NETHERLANDS

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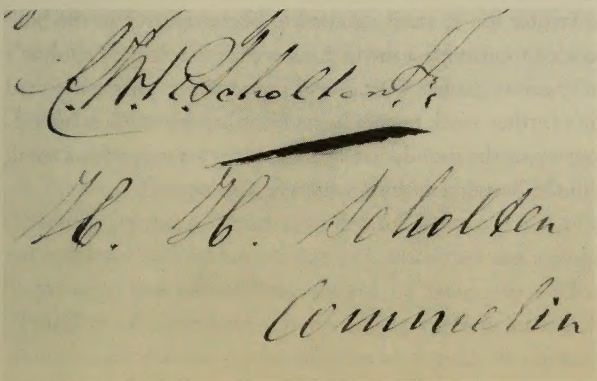
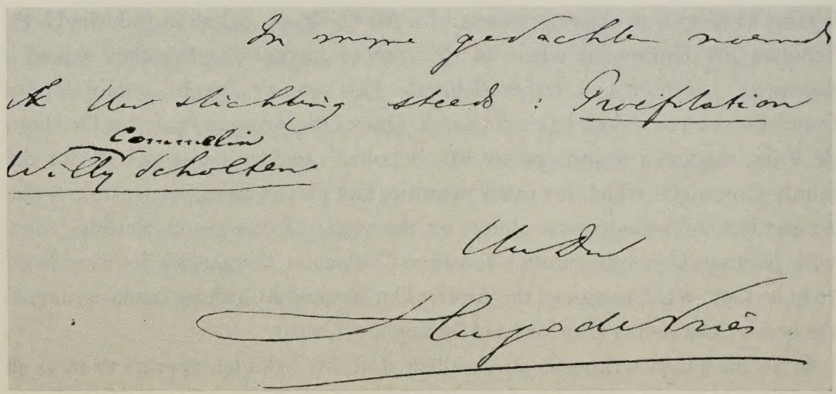
A laboratory is founded

It must have been an exciting moment for Mr C. W. R. Scholten and Mrs H. H. Scholten née Commelin when on the 18th of December 1894 they signed a document – written in a rather elaborate 19th century Dutch – establishing a foundation carrying their late son's name. One of the Trustees Professor Dr Hugo de Vries, suggested to incorporate Mrs Scholten's maiden name as well, for the family Commelin which for many centuries had played an important role in the Amsterdam community was almost on the verge of dying out (Kerling, 1957, with photographs of the family). Johannes Commelin, a botanist who lived from 1629 to 1692, was Director of the Amsterdam Botanical Gardens. Linnaeus named the genus Commelina after him and his nephew Caspar.

From his letters written in an excellent style Mr Scholten appears to us as an idealistic man, who wished to keep the memory of his son alive by founding a laboratory for biological research. Since Willie had shown himself highly interested in phytopathology when studying under the supervision of De Vries, this young branch of botany would be studied with the father's consent under the auspices of



Signatures of Mr C. W. R. Scholten and Mrs H. H. Scholten-Commelin.


In mijne gedachte noemt
ik Uw stichting steeds: Proefstation
Willy Commelin Scholten
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Hugo de Vries

Name of the laboratory as proposed by Professor Dr Hugo de Vries.

this new foundation. Its purpose therefore was research, education and giving practical advice to growers in plant diseases. Though Willie's friend Ernst Krelage, who was going to be a Trustee for 57 years, advised to begin research in the bulb growing area, it was decided to provide a site in Amsterdam where the Scholten's lived in a house with a spacious garden with greenhouses which originally had been destined for Willie's further work in case he had finished his studies. Intending to bequeath his property to the foundation, Mr Scholten arranged for a small laboratory to be made in the house next door which he also owned.

The period of giving advice on the control of plant diseases; the first Director

J. Ritzema Bos was asked to act as Director. He was a teacher at the School of Agriculture at Wageningen and he had a thorough knowledge of plant diseases. In a large number of letters to him Mr Scholten shows himself as a benevolent man, discussing conditions and explaining patiently that the laboratory had no commercial purpose but that he would do his utmost to establish the foundation. He gave his consent to wishes concerning funds for salaries, travelling and equipment though he admitted that expenses were higher than he first expected. In the spring of 1895 the Director took up his new post which in fact was a continuation of his former advisory work in Wageningen. In the following 11 years of his activities he made the laboratory a centre for all those who wanted advice on plant diseases, pests or other agricultural problems. His elaborate, highly educative, handwritten letters to farmers and growers often illustrated with drawings deal with fungi such as mildews or rusts, Sclerotinia libertiana attacking sunflowers, Botrytis tulipae or with control of noxious insects and mice. He advised how Bordeaux mixture or manure had to be prepared and even what crops ought to be sown in a field infested with nematodes. For identification of fungi or insects he enlisted the support of scientists such as C. A. J. A. and F. A. F. C. Oudemans. He wrote many articles for the periodical of the Netherlands Phytopathological Society, the 'Tijdschrift over Plantenziekten', which was edited in cooperation with the Belgian Society 'Kruidkundig Genootschap Dodonaea'. It served as a publication medium for the foundation.

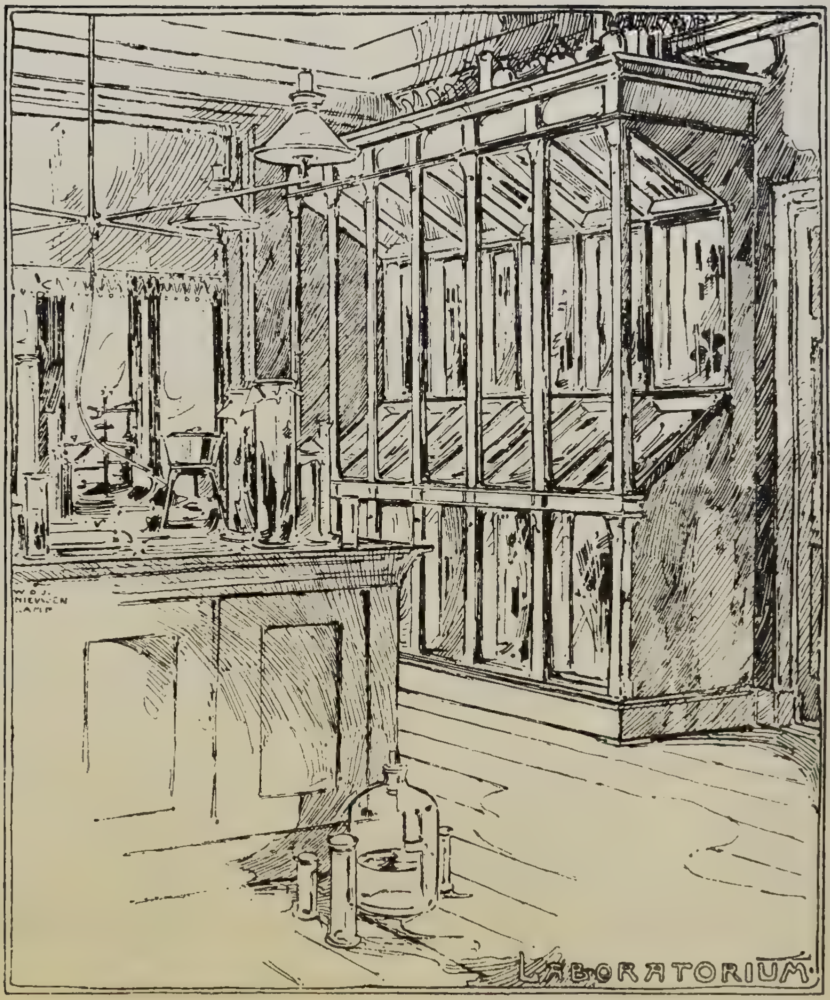
Scholten persuaded the University of Amsterdam to grant the title of Professor to Ritzema Bos, who in the inaugural lecture explained that in his opinion phytopathology was a science intended for the protection of crop plants independent of botany. Practical knowledge of horticulture and agriculture was indispensable, mycology and entomology should be taught to students in plant pathology. Teaching of chemistry was according to him, useless. Though the interest of Amsterdam students lay in different biological directions, Ritzema Bos could not appreciate their lack of practical knowledge. On the other hand, however, their teacher's ideas concerning fundamental biological or phytopathological problems,

Professor Dr J. Ritzema Bos. Water-colour picture by Dr G. A. de Vries after an oil painting probably dated 1919.

such as resistance or susceptibility, were rather vague, but as yet time did not seem to be ripe for such questions. Copies of thousands of his letters are still in the laboratory's archieves. Ritzema Bos himself estimated the number written in 1896 between 600 and 700. Most of his spare time must have been taken up with this writing of letters and articles while at the same time he travelled extensively, giving lectures all over the country. The small strictly private laboratory began to fulfil a general need.

Gradually the Director became more and more involved in national and international regulations concerning plant protection, specially in relation with gooseberry mildew and the San José scale. At his instignation the Dutch Government established in 1899 the 'Plantenziektenkundige Dienst', a service for crop protection, which under his directorship was housed in the Willie Commelin Scholten Laboratory. The Government granted a yearly subsidy of 7000 guilders. Though all phytopathological activities were in his hands Ritzema Bos was not satisfied. In a letter written in 1897 he complained about his position, having no time for scientific research and no place to carry it out. One has to remember, however, that the Trustees probably expected the Director to have a different approach to scientific activities, resulting first in minor, later in more serious controversies. When in 1906 Ritzema Bos was asked to accept the post of Director of the newly established 'Instituut voor Phytopathologie' at Wageningen it meant the end of the cooperation with the Willie Commelin Scholten institute. Early 1906 he went to Wageningen, taking with him the Plant Protection Service including the allowance of 7000 guilders, his assistant, H. M. Quanjer, the 'Tijdschrift over Plantenziekten' with its possibility of publication and even his personal title of Professor at the University of Amsterdam. Mr Scholten was desillusioned.

When reviewing the period from 1895 tot 1906 one has to bear in mind that phytopathology was still a study of separate cases of diseases. General rules were hardly discovered. Ritzema Bos, with his encyclopaedic knowledge saw as his task instructing and advising agriculturists, which resulted in an increasing understanding of disease symptoms. His books dealing with the most important diseases



Interior of the laboratory Roemer Visscherstraat 3, Amsterdam, probably dated 1896.
Drawn by W. O. J. Nieuwenkamp.

were used for many years. From the correspondence between Ritzema Bos and Scholten, one gets the impression that characters and backgrounds of the two men differed widely. On the one hand the man trained in the field, who wanted to use his knowledge directly for practical purposes and who did not see the value of pure scientific research that might have extended the still superficial knowledge. On the other hand Scholten was a business man, who certainly had shown great interest in his only son's study and who apparently preferred to see scientific studies carried out in his greenhouses or in the laboratory. Probably he never visited Bos' experimental fields, scattered throughout the country. When in 1905 Ritzema Bos was on the verge of leaving Amsterdam, Scholten was doubtful whether continuation of the laboratory was still worthwhile. Then Professor Dr F. A. F. C. Went one of the Trustees and Mr F. B. Löhnis pointed out that the relation of the foundation with the University of Amsterdam provided a unique opportunity to carry out scientific research. A large and important task still laid ahead according to Went's own words: 'We know so little of diseases that all research will enrich our knowledge'. His opinion that the laboratory should at the same time remain in contact with the practical world and with the Institute of Phytopathology at Wageningen, so as to avoid isolation, has proven to be valid up until today.

A woman as director: Johanna Westerdijk

In 1899, when an assistant was needed, the possibility was considered to ask Miss T. Tammes, a biologist from the University of Groningen, but it was unthinkable that a woman could fulfil an advisory task. In 1906, however, after Dr J. H. Wakker had refused to take on the directorship, a woman was appointed, Dr Johanna Westerdijk, a pupil of Hugo de Vries, 23 years old, clever, energetic and handsome. Her life and personality are described in relation to the development of the laboratory (Westerdijk, 1929 and 1952; Went, 1931; Kerling, 1957; Ten Houten, 1963; Löhnis, 1963; Kerling, 1966).

Being educated in Amsterdam Johanna had hardly knowledge of agriculture which induced Ritzema Bos to utter his doubt whether 'this lady would be able to take on his former task'. In a letter dated 12 September 1906 Went referring to this remark, advised Scholten to wait for the results of Johanna Westerdijk's work, and indeed short publications meant for growers and more elaborate papers written in foreign languages appeared before long.

Gradually more women entered the scene, mainly appointed to take care of a collection of fungi, called 'Centraalbureau voor Schimmelcultures' (Central Bureau for Fungus Cultures), which came under Johanna's supervision at the request of the 'Association Internationale des Botanistes'.

At first Westerdijk followed the old concept. She tried to advice farmers as well as she could, which was by no means an easy task. A woman though with increasing knowledge of the work was still an unusual appearance in the fields. Often she was insulted and once a bulbgrower rubbed a handful of soil into her face. Looking through her letters written in the first years of her directorship, it strikes one that she often asked for sending her once again certain diseased plant material, probably meant for isolating fungi or for carrying out experiments such as those with tomato virus, described in her first publication. Her research deepened, as appears from her report to the Trustees of the Foundation in 1917, in which she explains that she wants to restrict the number of diseases being studied as much as possible in order to find time for more detailed research.

'More women entered the scene'. From left to right: Catharina Cool, Johanna Westerdijk and Cato Sluiter.

Development of classical methods in phytopathology

A new period had started, which can be characterized as that of the development of the classical phytopathological methods which every student in this field still has to learn. Gradually the advisory task of the laboratory became less important, as it was taken over by the Plant Protection Service at Wageningen. An important aspect of the research program is clearly described by herself (1917 and 1920) as follows: 'The species concept of pathogenic fungi needs reviewing. It has to be based on appearance of fungus on different hosts in nature and on its characters in pure culture. Variations in spore measures due to differences in environmental conditions have to be taken into account and therefore herbarium material by it self is insufficient. The biometric method may reveal the existence of biological races which will have to be considered as belonging to one species.' Fungi were isolated from diseased plants, grown on different media and identified, their pathogenicity was tested by inoculation of the plant species from which they originated. It often appeared that they were no parasites at all but secondary invaders. Differences in virulence were detected of strains belonging to one species, such as Rhizoctonia solani. This promising line of applied research attracted enthusiastic young people to the laboratory and after Johanna was appointed Professor at the University of Utrecht in 1916, many publications conferred the title of doctor on her former students. The small laboratory crowded with people and material was in urgent need of larger accomodation to house the large number of phytopathologists and students. Also the lack of experimental plots was a constant problem mentioned in the discussions held at the meetings of the Trustees. A solution came when a large house standing in its own grounds was for sale in Baarn, about 40 km from Amsterdam. It was situated near the Hortus Botanicus, called the 'Cantons Park', of the University of Utrecht, where plants for experiments could be grown. In 1920 the Trustees decided to buy the house called 'Java'. Still in her old age Westerdijk dreamt of the exciting days when she moved from the unsuitable laboratory in Amsterdam to the spacious country house with its beautiful garden. There was a stable with a small house for a coachman which was found suitable for students lodgings. Though the equip-

The house 'Java'.

ment was still relatively simple, experiments were carried out in the garden and disease symptoms could be studied. Together with the German phytopathologist Otto Appel, Westerdijk published a phytopathological system of classification of diseases based on symptoms (Appel and Westerdijk, 1919). Also the pathological anatomy of the diseased plant was studied and an attempt was made to induce healthy plants to develop similar symptoms by infecting them with a parasite or by wounding. Attention got focussed on crop plants and ornamentals, often neglected in pure botanical studies.

Life cycles of pathogens are studied

From the theses and other papers which appeared from 1922 on only some of more general importance will be mentioned here. The first thesis that appeared from the laboratory after Van Hall had published his work on bacterial diseases (Van Hall, 1902) was that of M. Beatrice Schwarz (1922) on the Dutch elm disease and its parasite, Graphium ulmi which was isolated and described. Many phytopathologists and non-pathologists did not accept that this fungus was the cause of the dying of thousands of elms everywhere in the country. Pamphlets insulting Westerdijk were published but in a well written publication she defended her and Schwarz's point of view concerning the infectious character of the disease that occurs independently of weather conditions (Westerdijk and Buisman, 1929). She pointed to the way of control that up till now still seems to be the best one: growing resistant elms. In the same year, 1929, Christine Buisman started research on the elm disease with a breeding program. Moreover she completed the knowledge of the life cycle of the fungus by discovering the perfect stage of Graphium ulmi and by experiments, among others on the evaporation of diseased plants by which she tried to obtain more fundamental insight in the character of the wilting process. Questions were studied, such as whether the parasite had the ability to induce thyloses and gummosis also in trees other than elms (Broekhuizen, 1929) or the question whether a desinfectans could be found to clear the vessels of a diseased elm from the spores of the parasite without damaging the tree (Ledeboer, 1934). No wonder that such a substance was not found since none of the so much broader range of fungicides that are nowadays known, can be applied successfully to that purpose. After the early death of Christine Buisman in 1936 Johanna C. Went continued the breeding work and the selection of resistant elms up to 1953.

In 1922 Maria P. Löhnis' thesis appeared dealing with the attack of potatoes by Phytophthora infestans, the late blight. In further studies (1924) she tried to find a relation between the occurrences of outbreaks of the disease and weather conditions. Her observations led to the first warning service in the world that predicted epidemics based on critical weather conditions. She also observed the difference in

penetration of the fungus into the lenticels of potato tubers of susceptible or more resistant cultivars.

It was a time of hard work, new discoveries and also of much pleasure and jokes. The laboratory became internationally known, especially after a visit of the First International Phytopathological Congress held at Wageningen in 1923. When the economic situation in the country deteriorated, providing hardly any vacancies for biologi. ts, many came to Baarn to carry out research in order to obtain a doctor's degree for in 1930 Westerdijk was appointed Professor at the University of Amsterdam at the request of the students.

A great number of studies appeared on diverse subjects. Fungal diseases and also those of bacterial origin were analyzed. Experiments were carried out in the garden and also in a small glasshouse that was built at the cost of the University of Amsterdam. Diseases of raspberry, cucumber, beans, peas, flowerbulbs, tobacco, Primula, Viola or Lathyrus were studied. Disease symptoms of physiological origin were induced in plants grown in nutrient solutions of different composition (Mes, 1930). Also tree diseases other than the Dutch elm disease were studied; the bacterial disease of willows (Lindeijer, 1932), the bacterial canker of poplars by Koning (1938) and the effect of Polyporaceae on trees (Grosjean, 1942). 'Such a diversity of subjects of research in the laboratory should allow the students to become good diagnosticians'.

Studies on antagonism

It was A. van Luyk, appointed assistant in 1910 who next to Johanna Westerdijk brought stability to the laboratory during the 29 years of his activity. Though originally a potato breeder, appointed to give advice in agricultural questions (Westerdijk, 1950), he gradually became involved in describing species of fungi mainly based on spore measurements. These he critically analyzed statistically. He became an excellent mycologist, who together with Westerdijk published several papers on different pathogenic fungi. His studies on the cause of a disease of grass in golf links would finally lead to the discovery of antagonistic effects between microorganisms. After the parasitic character of fungi isolated from diseased grass roots was proved by their ability to infect grass seedlings grown in sterile soil, it appeared that in non-sterile soil such fungi exerted less effect due to the presence of antagonistic influences. To detect their origin, drops of soil suspension were added to sterile soil in which seeds of Lolium annuum were sown and a parasite like Pythium volutum was present. Dematium pullulans was one of the fungi isolated from the soil suspension that appeared to be highly antagonistic to the parasite. Sterile culture filtrate from this antagonist also inhibited growth of Pythium volutum and its ability to infect the seedlings. The toxicity of the filtrate seemed to depend on the composition of the medium on which the fungus was grown. Control of soil borne diseases by adding the antagonist to the soil was considered. The activity of its toxin might be stimulated by adding nutrients, perhaps carbohydrates. The modern idea of biological control is evident. Another still stronger antagonist to Pythium was Penicillium expansum, though its toxin, called expansine, had no effect on Fusarium spp. Adding this fungus to the soil seemed dangerous, since after killing saprophytic microorganisms, Fusarium spp. might survive and attack plant roots. Toxins of many other fungi were tested, among others that of Penicillium notatum. Its effect was however weak, contrary to that obtained with the same fungus by Sir Alexander Fleming. Apparently the Dutch and the English strain did not produce the antibiotic in the same degree. Fleming's isolation became world famous as penicillin, whilst Van Luyk's expansin is now known as clavacin or patulin. A choice from his experiments was published in

1938. More data of his pioneer work can be found in the unpublished annual reports of the Foundation from 1931 up to 1939, in which year he retired. Van Luyk passed the years of the war in the province of Zeeland. After his return to Baarn he was engaged by a commercial firm, which must have supplied him with a welcome addition to his meagre old age pension. In 1946 he was officially honoured when the University of Utrecht offered him the degree of doctor honoris causa. Many people of the older generation remember Van Luyk as a modest, extremely helpful man with a great knowledge of fungi and a great ability to culture them, remaining somewhat hidden behind Westerdijk's fascinating personality. Yet he has put his mark on several studies concerning antagonism between fungi (Jaarsveld, 1940) or antagonistic factors in natural soil (Ten Houten, 1939).

Part of the garden as it was in 1920

Financial problems; wartime

Though the laboratory of the Foundation seemed to prosper, its Director was not without care concerning the financial position. After the laboratory had moved to Baarn the income had not increased in relation to the growing number of students, the expenses for necessary equipment and the continual need of money for paying salaries. To solve this problem the coachman's house was let and gifts were asked from private persons. The 'International Education Board' in New York sent money, also the Indonesian Institutes and the 'Association internationale des Botanistes', the latter for keeping up the growing fungus collection. Even old periodicals were sold to increase the income. It was the University of Utrecht that saved the foundation from closing down the laboratory in 1922, by giving a subsidy for teaching purpose and by paying salaries. The greater part of the research programm was paid for by industries or semi-official Government Institutions. Studies were carried out on bulb diseases, fungicides, fruit rots of Citrus fruits and apples, on the possibility to obtain alcaloids from Claviceps purpurea grown in vitro, on attack of Lathyrus by Thielaviopsis basicola or on leaf spots on Deli tobacco caused by Cercospora nicotianae.

Mr Odo van Vloten, a tea planter from Indonesia, interested in the collection of fungi of the 'Centraalbureau voor Schimmelcultures' supported it with a yearly gift. He even made it possible to build new rooms to the laboratory in order to house the collection and to provide for seats for mycologists. Johanna's friend Dr Maria P. Löhnis, provided money to rebuild the stable into a room for practical work. Next to the financial help from the Universities – Amsterdam granted money for teaching purpose and a salary for a gardener – it was again money from private persons and institutions that kept the laboratory going. When in 1931 Mr Van Vloten died, it appeared he had bequeathed the income of a great deal of his capital to Westerdijk 'in favour of her Centraalbureau'. The Bureau had to become a foundation in order to accept this legacy, which meant that it became independent of the 'Willie Commelin Scholten' foundation, though the Trustees of the latter became responsible for the execution of the Will.

Though money came in from different sides the Director must have worried

constantly how to pay the rising salaries or how to feed the growing collection. The 'Mededelingen' could no longer appear. After 1938 all articles were sent for publication to different journals. During the war years 1940 to 1945 it became increasingly difficult to continue the work. Nutrients for the fungus collection were hard to obtain, there was no possibility for autoclaving the media through lack of gas and electricity and many people had to leave the laboratory for different reasons. The celebration of the golden jubilee of the Foundation in 1944 was only modest: there was a tea at the laboratory where every guest received a parcel of food to take home.

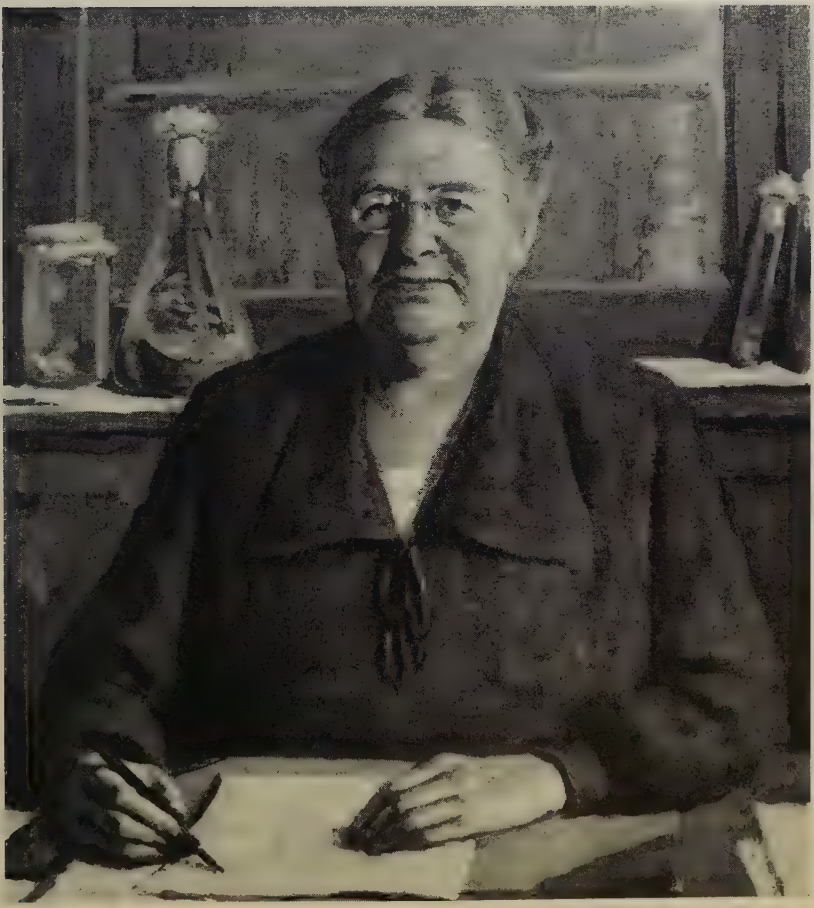
Interior of the house 'Java'.

Last years of Johanna Westerdijk's directorship

After the war new activities started such as research on a disease of Alnus glutinosa carried out by the South-African guest Dr S. J. Truter (1947). The biology of Nectria cinnabarina, a fungus with a damaging effect on some elm clones resistant to the Dutch elm disease was studied by Uri (1948) and damage by Nectria species of willows by Mooi (1948). It was difficult to find assistants, since everywhere in the country there was a demand for people with academic degrees and those still student wanted to finish their study without delay. In 1949 J. A. von Arx came over from Switzerland, an excellent mycologist and able leader of the practical work. Also G. van den Ende was appointed.

When reviewing this last period it is clear that war circumstances and also the difficult situation in the country thereafter compelled Westerdijk to restrict her activities instead of realizing her ideas as energetically as she used to do. Moreover there was the constant struggle against shortage of money. One of the Trustees of the Foundation, Dr G. Wilbrink uttered more than once her amazement on the small amount of money with which so much good work could be carried out.

At the end of 1952 Johanna Westerdijk retired as Director of the Foundation. Over forty six years of her life had been dedicated to the development of phytopathology and mycology. Under her guidance a great number of young people had learned to find pleasure in carrying out research, to discover the character of a fungus or the behaviour of a parasite in a host plant. Studies appeared in a wide field of mycological and phytopathological problems, on parasitic and non-parasitic fungi, on soil borne diseases and on those of physiological origin. The small laboratory without hardly any equipment where she had started in 1906, had not only grown but it had produced a second, world famous foundation, the 'Centraalbureau voor Schimmelcultures'. For Johanna Westerdijk periods of hard work and worries concerning the financial position of the laboratory alternated with more pleasant events such as the journeys to Indonesia, Japan and the U.S.A., later to South-Africa, the celebration of her 25 years directorship, the surprise when receiving Odo van Vloten's legacy, her membership of the Royal Netherlands Academy of Sciences and last of all, the tribute paid to her when she left her



Professor Dr Johanna Westerdijk after an oil painting by J. Bruyn, dated 1952.

post. In presence of hundreds of guests she gave her last lecture, reviewing her life, which can be best characterized by quoting the aphorism by her instruction inscribed above the door giving entrance to the room for practical work: 'Werken en feesten vormt schone geesten' (Working and feasting form fine spirits). On that occasion the contribution of friends handed over to her, consisted in a sum of money 'Het Johanna Westerdijk Fonds' meant to support phytopathological and mycological activities and of which she could freely dispose. Earlier another foundation with a similar purpose, though only meant for women, was established by the parents of Christine Buisman after her early death in 1936.

Johanna Westerdijk's successor was Louise C. P. Kerling, who took the directorship of the 'Willie Commelin Scholten' foundation over in 1952. Johanna remained in care of the 'Centraalbureau voor Schimmelcultures'.

The third director, again a woman. Extension of the laboratory

When the new Director inspected her territory she realized that there were not enough places for students in the laboratory. There was not even sufficient room for a centrifuge which was ordered. The Trustees took, however, some important decisions: the Universities of Utrecht and Amsterdam would be asked to appoint all people working in the laboratory who were not yet in their service, which would guarantee them an old age pension. This measure not only meant a personal relief but also a relief to the foundation which was now no longer responsible for paying salaries. It was also decided that the foundation would build a new wing to the old house, which itself had to be renovated and that the Universities would rent the complete building. Simultaneously with the enlargement of the laboratory a temperature-conditioned glasshouse was built paid for by the University of Utrecht, destinated for virus research and other experiments. In July 1957 the laboratory and the glasshouse were ready for use.

In the meantime teaching and research had to continue. Von Arx, the leader of the students work, occupied himself mainly with mycological problems. Together with E. Müller, a Swiss mycologist, he published a review of the amerospore and later also of the didymospore Pyrenomycetes (1954 and 1962). In about 1350 pages the results of a careful comparison of herbarium material and data from literature were laid down. A revision of the fungi considered to belong to the genus Colletotrichum appeared to be extremely helpful to phytopathologists (1957). It was soon out of print. Between these elaborate studies other ones appeared on new or interesting diseases such as on a disease of willows on Cylindrosporium padi, causing spots on cherry leaves and on a disease of Allium porrum. After Von Arx was nominated Director of the Centraalbureau (1963) his further publications did no longer appear as from the 'Willie Commelin Scholten' laboratory but from the 'Centraalbureau voor Schimmelcultures'. Other studies concerned problems that had risen in practice and on which advice had been asked, such as that of a disease of young oaks overgrown with Diaporthe eres. This appeared to be due to bad conditions in the nurseries which because of the growing population of villages, were removed from the sandy

Professor Dr Louise C. P. Kerling.

ridges along the river to heavy clay soils (Kerling, 1961). Also parasites and diseases of a diversity of crop plants such as onions and cucumber were studied. The life cycle of Exobasidium japonicum on Azalea was clarified by W. Graafland (1960). The damage by Septoria nodorum of wheat was studied by G. J. F. Becker on behalf of the 'Nederlands Graan-Centrum' (Netherlands Grain Centre). To some extent the original line of research followed in earlier years was continued and will have to be continued in future, since many students want to be educated in phytopathology in order to find a place as research officer at a horticultural or agricultural station. Contact with such stations during their student time may be an introduction to the type of work that is required in such an applied field of phytopathology.

Recent research

Gradually more fundamental work was accomplished, but for modern research the equipment was insufficient. Isotopes had to be used, ultracentrifuging had to be possible especially for purification of viruses, a spectrophotometer and other instruments had to be available. Without such expensive tools research would remain below the international level and the laboratory would loose its grip on the students. The Universities of Utrecht and Amsterdam understood the need of expansion and increased their credits. There were happy moments every time a new instrument could be installed. The new equipment asked, however, for space as did the increasing number of staff members and assistants. Two successive reconstructions of the laboratory brought a solution to this problem. First the library moved into the flat formerly occupied by Johanna Westerdijk, who passed away in November 1961. It was transferred into a spacious quiet room, suitable also for reading and study. Here the work of W. H. Schuster, librarian, has to be mentioned. By his knowledge and great care the library is now considered a model for a specialized institute, containing a unique amount of well catalogued information on phytopathology and mycology. In 1964 a second reconstruction took place when the Centraalbureau moved to a new building, established in the garden of the Foundation 'Willie Commelin Scholten' and connected with the old laboratory by a corridor, because the library was left undivided. The rooms left by the mycologists were changed into a physiological and a virological laboratory. Two rooms were reserved for research with isotopes. The ordering of the equipment and the planning of the reconstructions asked much time from all staff members. Another extension took place in 1965. After a number of students from the 'Free University' at Amsterdam had chosen phytopathology for their final examination, the Directory of this university asked officially for admittance to the laboratory. The Foundation warmly welcomed this university being the third which showed interest in education and study of plant diseases.

In the meantime research continued. A. de Lange had taken over the testing of poplar hybrids on resistance to bacterial canker from G. van den Ende. A new aspect came in, when in France Ridé discovered the real parasite of this disease,

Corner of the library.

Canker caused by Aplanobacter populi on Populus candicans.

Aplanobacter populi, which was also detected in the Netherlands (De Lange and Kerling, 1962). The bacterium can now be grown in vitro and testing of poplars on resistance has become a routine procedure which was handed over to the 'Bosbouwproefstation De Dorschkamp' (Forest Research Station) at Wageningen. The character of the canker-inducing bacterium was further studied in vitro by inoculation of callus tissue developed on poplar explants. Hyperplastic proliferations appeared to be nutrient dependent. From slowly growing and weather influenced trees in the field this object of study was reduced to a collection of stem pieces in tubes (De Lange, 1968).

After Johanna Went had left the laboratory in 1953 many unsolved questions remained in relation to the Dutch elm disease (Went, 1954). Initially supported by the 'Tendeloo-Fonds', a private foundation, H. M. Heybroek and an assistant were finally appointed by T.N.O., (Central Organisation for applied Research in the Netherlands). Breeding and selection of resistant elms could be continued, which resulted in the release to growers of a fairly resistant hybrid, the 'Commelin' elm, and a highly resistant one, the 'Groeneveld' cultivar, which nowadays are frequently grown in the Netherlands (Heybroek, 1961 and 1963). In 1958 V. Tchernoff was appointed in order to obtain more information on the validity of the methods used in growing, inoculation, screening and selection. The results of his five years research are laid down in two publications, which contain much useful information for the breeder as well as for fundamental work. Especially the possibility to grow genetically uniform plant material derived from one mother tree has proved to be of importance for further research (Tchernoff, 1963 and 1965; Kramer, 1967). Sprouts developed from root callus are rooted under misting and grown for a year in the glasshouse or outside. Great numbers of identical cuttings originating from a mother tree susceptible to the Dutch elm disease or from a resistant one, allowed D. M. Elgersma to start research on the physiology of the disease. It appeared that spore transport in the xylem vessels after inoculation of the trees with the parasite Ceratocystis ulmi, was different in resistant elms from that in susceptible ones. In the latter an all over infection took place, whilst in the resistant trees spore transport was inhibited, probably by a more effective occlusion of the xylem vessels due to the anatomical structure of the vascular system (Elgersma, 1967 and 1969). The character of the disease was studied by determining the amino acid and the sugar content of xylem- and bleeding sap in resistant and susceptible, healthy and diseased plants, grown in soil, in nutrient solutions without or with K, Ca or Mg-deficiency. Also pectolytic enzyme activity was determined. Though the many dates that are gathered do not yet allow a clear insight into the mechanism of wilting of infected elms, it seems that many hypotheses concerning the processes that occur in diseased trees have to be re-

Left: callus ring developed from the cambial layer of a root piece of Ulmus hollandica 'Belgica'. Right: sprouts developed from the callus ring.

viewed. Further research in the field of biochemistry or histochemistry has to throw more light on the processes concerning the interactions between the parasite and the tissues surrounding the xylem vessels. In cooperation with C. A. Salemink, 'Organisch Chemisch Laboratorium' of the University of Utrecht, the composition of the toxin produced by Ceratocystis ulmi was determined by H. Rebel (1969).

Apart from the study of this wilt disease of a woody host plant, that needs time for growing and that only may react with the parasite during a few weeks in early

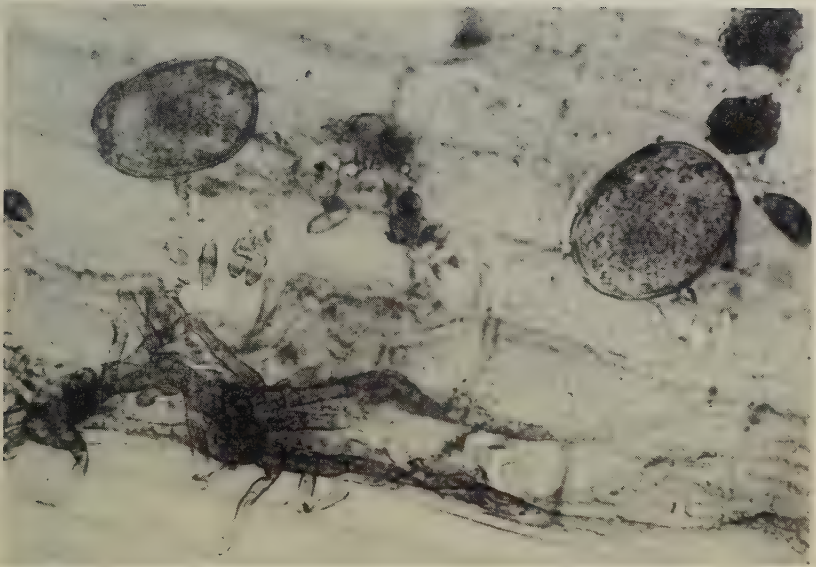
Elms grown on nutrient solutions of different composition.

summer, Verticillium attack of some herbaceous plants was studied. They could be grown rapidly and ad libitum. It threw some light on this parasite (Van den Ende, 1958), but it led also to studies in the field of soil ecology, the line of research introduced by Van Luijk and taken up by B. Schippers. After systemic growth of Verticillium albo-atrum in tolerant weeds was discovered by Van den Ende, the fungus appeared even to be present in the achenes of infected common groundsel plants, Senecio vulgaris. When germinated in natural soil the parasite disappeared by the antagonistic effect of soil microorganisms (Schippers and Schermer, 1966).

Van Luyk's valuable idea to induce such effects against parasitic soil fungi by adding antagonistic fungi to the soil, has, however, appeared to be less simple than it was initially thought. The relation between a pathogen, the surrounding soil and the plant is highly complicated. What might happen in natural soil to a parasite under different influences such as the presence of a root of a hostplant is studied by Schippers and students: the survival of pathogenic fungi in natural soil, their formation of resting bodies, fungistasis and lysis as influenced by microorganisms (Schippers, 1969a and b). The stimulation or inhibition of antagonistic activity by adding organic manure or pesticides to the soil is integrated in the program. Also the influence on pathogens of root exudates of susceptible or resistant cultivars is studied (Schippers, Schroth and Hildebrand, 1967; Schippers, 1969a). Soil pollution by the use of chemicals for control of soil borne diseases may disturb the antagonistic activity present in natural soil. By increasing knowledge of the relations between pathogenic organisms and their environment it might be possible to turn the antagonistic forces present in the soil to advantage of the plants. A biological or integrated control might be developed, the responsability of which is up to biologists.

A new aspect was the relation between a leaf and the saprophytic or parasitic microorganisms present on its surface, i.e. in the phyllosphere. The influence of leaf exudates on the behaviour of a parasite was studied by H. H. Sol. The composition of the exudates from leaves of Vicia faba appeared to depend on the nutrient solution on which the plants were grown. A correlation was found between sugar- and amino acid contents of the exudate, the rate of germination of spores of Botrytis fabae and the number of lesions caused by this fungus. When the plants were fed with $C^{14}O_2$, the C^{14} could be detected on or in the germinated Botrytis spores that were kept on the leaves of the treated plants for 6 hours (Sol, 1969).

Also other questions concerning the phyllosphere are studied, such as that of antagonistic interactions between saprophytic and parasitic microorganisms present on leaves. Lesion development on those of Phaseolus vulgaris caused by Alternaria zinniae could be reduced by several saprophytes, e.g. Aureobasidium


Development of Cladosporium herbarum on a rye leaf stimulated by the presence of rye pollen.

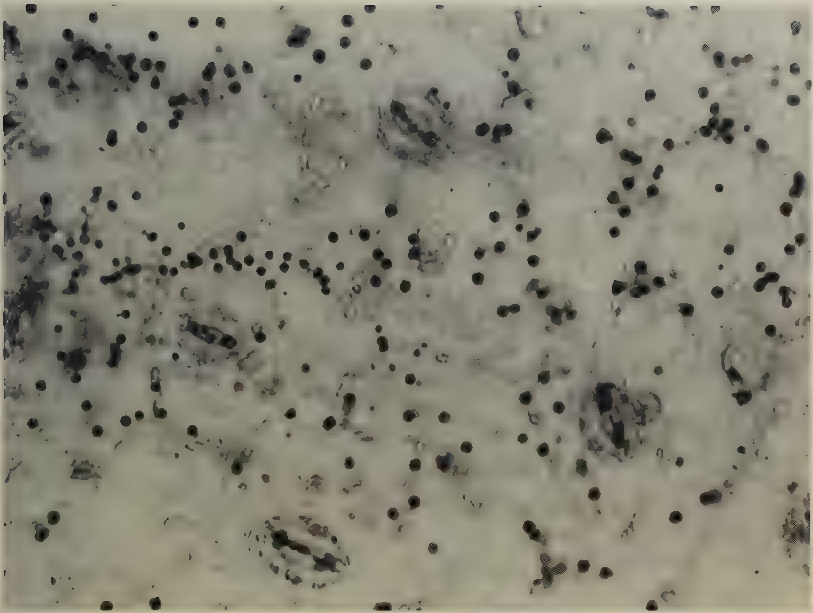
pullulans (Van den Heuvel, 1969). The microflora present on beet and rye leaves was determined. On the latter a sudden increase of yeasts, bacteria and saprophytic fungi occurred in the middle of June, independent of weather conditions, a period in which no increase in leaf exudates could be detected. It appeared that nutrients leached from big quantities of pollen present in the phyllosphere, stimulated development of microorganisms. Also leaf parasites may be stimulated (Fokkema, 1968).

Transport of virus in stems and leaves of tobacco plants was studied under influence of healing wounds or meristematic tissues (Brants, 1961). In excised roots virus never seemed to reach the meristematic root tip. Growing virus-free

potato plant material from excised stem meristems was successfully tried, first by W. Graafland. After his tragic death meristem culturing was continued by D. Hendrina Brants. A great number of Freesia-hybrids could be freed from virus, which is of great importance for growers. When the method had reached the stage of routine procedure it was handed over to them. Meristem growing of Freesia's is now performed at large scale at laboratories of the 'Nederlandse Algemene Keuringsdienst' to the benefit of all growers interested in virus-free Freesia cultivars (Brants and Vermeulen, 1965).

Schippers (1963) studied transport of bean common mosaic virus in Phaseolus vulgaris in relation to seed transmission. It became clear that only infection at an early stage of the development of an ovule can lead to seed transmission of the virus. Necrosis of buds occurred when at the time virus reached an infectious level in the plant, the embryo-sac within the ovules developed from a mono-nucleate into an eight-nucleate state. When infected after this critical period only healthy seeds were produced. G. T. N. de Leeuw studied the translocation pathways followed by tobacco mosaic virus in hypersensitive Xanthi tobacco plants. Systemic infection followed by necrotization of internal and external phloem tissue occurred after grafting the plants on systemically infected tobacco plants or by transferring inoculated plants from 30°C to 24°C (De Leeuw, 1968).

The rapid development and increasing specialization in phytopathology made it desirable to appoint a lecturer in the field of virus research. In 1963 D. H. Brants was nominated as such. When paying attention to the leaf surface, she demonstrated by marking tobacco mosaic virus with C^{14}, that this virus material accumulates on a tobacco leaf at the sites of the ectodesmata (Brants, 1965). Ectodesmata also appeared to be present in root hairs of tomato plants. They are probably the infection sites for tobacco mosaic virus in soil. Recently a new aspect was added to virus research. It became evident that a fungus culture grown in vitro can be infected with a virus that probably multiplies in the hyphae. This fact can be of importance for the spread of viruses in soil. Moreover such a host-virus system can be studied in vitro under different conditions (Brants, 1969).



Epidermis of a leaf of Nicotiana tabacum cv 'Samsun' showing ectodesmata.

General outlook

Focussing on the three topics concerning transport of virus or of fungi through plants, and the study of questions related to the rhizosphere and the phyllosphere, stimulated the contact between all staff members. The number of phytopathological aspects has declined in comparison to former years when the cause of a great number of diseases still had to be investigated. The character of the problems which are studied has changed. Attention is more and more focussed on fundamental phytopathological questions in relation to ecological, physiological and biochemical aspects. Students join the staff members' research in working out minor problems after they have followed one or two courses to become familiar with techniques used in different branches of phytopathology. The study of interaction between host and parasite and of the influence of environmental conditions on disease development are the actual problems with which the present students are confronted. The educational task takes much time of the staff members. Though all people working in the laboratory are appointed by one of the three universities, inside the laboratory they form a team with the task to let the dayly machinery run as smoothly as possible. This situation comparable to that of an interuniversity institute, has many advantages in scientific as well as in financial aspects. Relations with other laboratories of the three universities are easily realized just as those with the phytopathological institutes at Wageningen and the experimental stations all over the country.

Also international contacts were established and many foreigners asked for a temporary place in the laboratory, while staff members worked abroad with the help of a fellowship for a shorter or longer time, which enabled them to widen their view and to apply new methods.

Though the equipment of the laboratory is highly improved thanks to grants of the universities, scientific advances and new developments ask for still new provisions. The need of climate rooms is urgent and also the wish to have an electron microscope is frequently uttered. An undisturbed development of the laboratory as a centre of phytopathological research might realize these wishes. In reviewing the 75 years of its existence it must be emphasized that the private initiative of Mr

and Mrs Scholten has led to the establishment of a small laboratory with modest means which nowadays has developed into a modern institute, kept up by three universities and with international relations.

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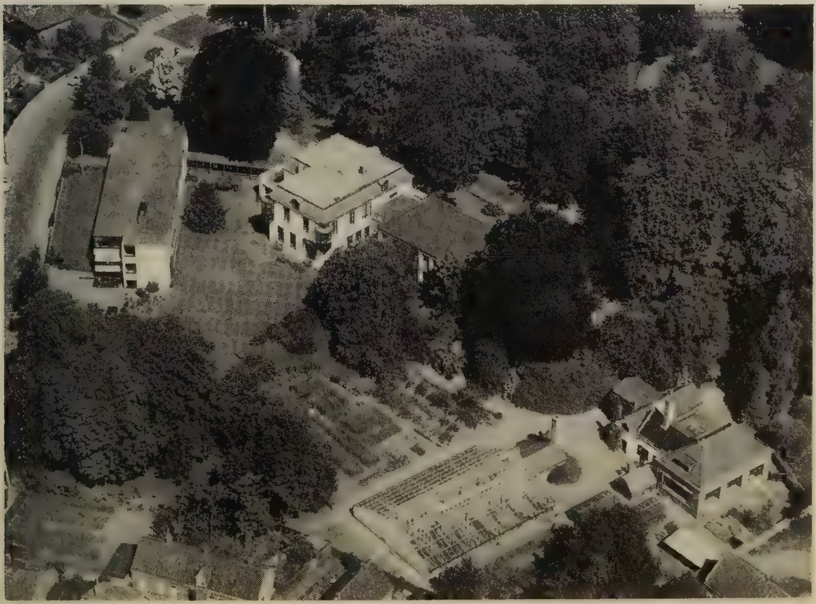

Aerial view of garden and buildings of the Phytopathological Laboratory 'Willie Commelin Scholten'. The 'Centraalbureau voor Schimmelcultures' on the left. Foto KLM Aerocarto.

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